

## **LAMINATED FACE FOR GOLF CLUB HEAD AND METHOD OF MANUFACTURE THEREOF**

### **CROSS REFERENCE TO RELATED APPLICATIONS**

**[0001]** This application claims the benefit of priority of US Provisional application serial number 60/454,566 filed on March 17, 2003, entitled "A LAMINATED FACE FOR A METAL GOLF CLUB HEAD" and which is incorporated by reference in its entirety herein.

### **BACKGROUND OF THE INVENTION**

**[0002]** The invention relates in general to golf clubs and more specifically to golf club head faces.

**[0003]** Conventional construction of golf drivers and "woods" include club heads made from wood, metal or a combination of materials. An increasingly more popular design includes a hollow metal club head with a secured metal face for striking the golf ball. Some conventional designs include increasing the size of the club head and decreasing the thickness of the face in order to take advantage of the "trampoline effect". The "trampoline effect" occurs when a flexible membrane rebounds after being deformed to launch the ball at an increased velocity from the membrane. The face deforms during the initial contact with the ball and rebounds to accelerate the ball from the face at a higher velocity than resulting with a non-deforming face. One drawback of the conventional designs having flexible faces is that the flexing face must make contact with the ball at the geometric center of the face to fully gain the advantage of the trampoline effect. The location is commonly referred to as the "sweet spot". Maximum distance and accuracy occurs when the face contacts the golf ball at the sweet spot.

**[0004]** In attempts to improve the performance of designs employing a flexing face, some implementations include an additional stop plate connected to the club head behind the flexing face. These designs, however, still suffer from limited performance.

**[0005]** In addition, some golf organizations limit the coefficient of restitution (COR) of golf clubs. The COR indicates, at least indirectly, the velocity that a golf ball will be launched from a club when the ball is hit with a club at a specific velocity. The United States Golf Association (USGA) limits the COR to 0.83 when the club impacts the golf ball at a speed of 160 feet per

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second. Conventional techniques for increasing the trampoline effect result in COR values that may exceed regulation limits.

**[0006]** Accordingly, there is need for a golf club head with a maximum golf ball contact area on the golf club head face that results in maximum driving distances and accuracy while remaining within regulation limits.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0007]** FIG. 1 is an illustration of a perspective view of a golf club head having a laminated face in accordance with an exemplary embodiment of the invention.

**[0008]** FIG. 2 is an illustration of a top view of an exemplary laminated golf club head face having ridges.

**[0009]** FIG. 3 is an illustration of a back view of the exemplary laminated golf club head face having ridges.

**[0010]** FIG. 4 is an illustration of a sectional top view taken along line 4-4 of FIG. 3 of the exemplary laminated golf club head face having ridges.

**[0011]** FIG. 5 is an illustration of a sectional top view of an exemplary laminated golf club head face having securing tabs.

**[0012]** FIG. 6 is a flow chart of an exemplary method of manufacturing a golf club head having a laminated golf club head face.

### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

**[0013]** In an exemplary embodiment of the invention, a laminated face for a golf club head includes at least one back face connected to a front face. Although the back face may be secured to the front face in any of several ways, the back face is welded to the front face in the exemplary embodiment. The laminated face is attached to a club head body to form a golf club head providing superior performance to conventional golf club heads. In addition to other

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advantages, the exemplary golf club head provides a larger contact area surrounding the "sweet spot" on the striking face that exhibits performance similar to the sweet spot when the golf ball contacts the face within the contact area. The exemplary design, therefore, results in a golf club that is more forgiving than conventional designs allowing a golfer using a club with the exemplary golf club head to experience improved accuracy and distance when striking a ball that is misaligned with the geometric center (sweet spot) of the face. In other words, the golfer will experience accuracy and distance similar to those achieved when the ball is hit at the sweet spot when the face contacts the ball within an area around the geometric center that is larger than provided by conventional golf clubs. In addition, the exemplary golf club head has a coefficient of restitution (COR) that is within the regulation limits.

**[0014]** FIG. 1 is a perspective view of a golf club head 100 in accordance with the exemplary embodiment of the invention. A laminated golf club face 102 is mounted to a head body 104 to form a golf club head 100. A shaft 106 is connected to the club head 100 to form a golf club for use as a "wood", or a "metal wood". In the exemplary embodiment, the club head body 104 is formed from a titanium alloy and includes a hollow interior. A variety of shapes, as well as other materials, may be used to form the head body 104 in some circumstances. For example, aluminum, wood, plastic, titanium, stainless steel, Al-Mg alloys, steel alloys, and other metals with sufficient elasticity and plasticity characteristics may be used to form the golf club head body 104 in some circumstances.

**[0015]** In the exemplary embodiment, the laminated face 102 is connected to the head body 104 by welding. As discussed below in further detail, a suitable welding technique includes welding the laminated golf club face 102 to the club head body 104 using Argon arc welding techniques. Other methods that may be used in some circumstances include other types of welding techniques such as other GMAW (gas metal arc welding) methods, friction welding, laser welding, and plasma welding. In addition, an epoxy, glue, or other adhesive may be used to bond the laminated face 102 to the golf club head body 104. Further, the laminated golf club face 102 may be cast with the body 104 or a SPDF (super plastic deforming) technique may be used in some situations.

**[0016]** FIGs. 2 – 4 are illustrations of various views of a laminated golf club face in accordance with the exemplary embodiment of the invention where FIG. 2 is a top view, FIG. 3 is a back view, and FIG. 4 is sectional top view taken along line 4-4 of FIG. 3. At least one back

face 204 is secured to the front face 202 to form the laminated golf club face 102. In the exemplary embodiment, a single back face 202 is welded to the front face 204 along the periphery of the back face 202. The weld 302 seals the front face 202 to the back face 204 to form a sealed region 208 between the two faces 202, 204 in the exemplary embodiment. The sealed region 208 may be filled with a liquid, solid, or gas depending on the desired performance of the laminated golf club face 102 and other factors such as the material and shapes of the faces 202, 204 and the club head body 104. In the exemplary embodiment, a gas such as air or carbon dioxide is retained within the sealed region 208. In some circumstances, the back face 204 may be secured to the front face 202 without sealing the perimeter.

**[0017]** In the exemplary embodiment the back face 204 is welded to the front face 202 by Argon arc welding. Other methods that may be used in some circumstances include the use of adhesives and other types of welding techniques such as other GMAW (gas metal arc welding) methods, friction welding, laser welding, and plasma welding.

**[0018]** Although the back face 204 has dimensions that are slightly smaller than the dimensions of the front face 202 in the exemplary embodiment, the back face 204 may be significantly smaller than the front face 202 and may have any of several configurations. The front face 202 and the back face 204 are cut and forged from titanium alloy sheets. Other materials that may be used in some circumstances include stainless steel, Al-Mg alloys, steel alloys, and other metals with sufficient elasticity and plasticity characteristics. The choice of material and the dimensions of the faces 202, 204 depend on the elasticity and plasticity characteristics, impact strength, welding properties and other factors. As will be recognized by those skilled in the art based on these teachings and known principles, the choice of material depends on the elasticity modulus,  $E$ , and the elastic power,  $W_E$ , the ratio of the tensile strength ( $\sigma$ ) to the elasticity modulus ( $E$ ), and the ratio of the tensile strength ( $\sigma$ ) to the plasticity coefficient ( $\Phi$ ) among other factors. In most circumstances, the choice of material should maximize the tensile strength to elasticity modulus ratio ( $\sigma/E$ ) and should minimize the tensile strength to plasticity coefficient ratio ( $\sigma/\Phi$ ).

**[0019]** In the exemplary embodiment, the front face 202 and the back face 204 are forged from the same material. In circumstances where the faces are of different materials, the tensile strength ( $\sigma_{BACK}$ ) of the back face 204 should be approximately 7% to 16% greater than the

tensile strength ( $\sigma_{\text{FRONT}}$ ) of the front face 202 and the plasticity ( $\Phi_{\text{BACK}}$ ) of the back face 204 should be approximately 5% to 14% less than the plasticity ( $\Phi_{\text{FRONT}}$ ) of the front face 202.

**[0020]** The configuration and thickness of the faces are selected in accordance with the elasticity and plasticity of the materials and the desired behavior and performance of the laminated golf club face. An example of a suitable thickness of the front face 202 is in the range from 1.2 mm to 2.5 mm. In the exemplary embodiment, the front face 202 has a uniform thickness of approximately 2.2 to 2.5 mm and is slightly convex although, in some circumstances, the front face 202 may be planar.

**[0021]** The back face 204 is forged from a sheet of titanium alloy to include embossed ridges 206 in the exemplary embodiment. The back face 204 has a shape similar to the front face 202 and is slightly smaller to allow a sufficiently large area around the back face 204 to apply a weld 302. The back face 204 may have other shapes in some circumstances. For example, the back face 206 may be a circle, ellipse, rectangle, square trapezoid, hexagon, or other polygon and may be significantly smaller than the front face 202. In the exemplary embodiment, the area of the back face 204 is between 70% and 90% of the area of the front face 202. The back face 204 is aligned with the front face 202 such that the back face 204 is centered within the area of the front face 202 in order to equally distribute force to the back face 204 during an impact with a golf ball.

**[0022]** The thickness of the back face 204 is less than the thickness of the front face 202 and depends on the thickness of the front face 202, the characteristics of the club head body 104, and other factors. A suitable thickness of the back face 204 is in the range from 0.7 millimeters (mm) to 2.5 mm. In the exemplary embodiment, the back face is about 1.0 to 1.2 mm thick.

**[0023]** The position and size of the ridges 206 depend on the tensile strength of the back face material ( $\sigma_{\text{BACK}}$ ), the thickness of the back face 204, the distribution of the stress-strain on the front face 202 and the ratio of the tensile strength of the front face material ( $\sigma_{\text{FRONT}}$ ) to the tensile strength of the back face ( $\sigma_{\text{BACK}}$ ). The ( $\sigma_{\text{FRONT}}$ )/ ( $\sigma_{\text{BACK}}$ ) ratio should be maintained within a range of approximately 0.85 to 1.0. In the exemplary embodiment, the back face 204 includes four ridges 206 that extend away from the front face 202 where two lateral ridges 206 are

slightly larger than two vertical ridges 206. The back face 204, however, may include any number of ridges 206.

**[0024]** In the exemplary embodiment, the back face 204 is slightly convex and contacts the front face only along the weld 302 such that the distance between the front face 202 and the back face 204 is approximately 2 mm to 5 mm. The back face 204, therefore, is substantially parallel to the front face 202 at a uniform separation. In some circumstances, the back face 204 may be planar forming a configuration where the centers of the faces 202, 204 are separated at a greater distance than the other portions of the faces 202, 204.

**[0025]** FIG. 5 is an illustration of a section top view of an exemplary laminated golf club face 500 where the front face 202 includes securing tabs 502. The securing tabs 502 facilitate welding of the laminated golf club face to the golf club head body 104.

**[0026]** Those skilled in the art will readily recognize the appropriate modifications to the dimensions and configurations of the front face 202 and back face 204 with the use of other materials based on the teachings herein.

**[0027]** FIG. 6 is a flow chart of an exemplary method of manufacturing a laminated face golf club head 100. Those skilled in the art will recognize that other techniques, methods, and equipment may be used to make a laminated golf club face 102 and a golf club head with a laminated golf club face 102.

**[0028]** At step 602, the front face 202 and the back face 204 are cut and forged from metal sheets. In the exemplary embodiment, a titanium alloy sheet having a uniform thickness of approximately 2.2 to 2.5 mm is cut and forged to form a slightly convex front face 202. The shape of the front face 202 is primarily dictated by the configuration and shape of the golf club head body 104 to which the laminated golf club face 102 will be attached. The back face 204 is cut and forged from a titanium alloy sheet that is approximately 1.0 to 1.2 mm thick to form a back face 204 with ridges 206 in the exemplary embodiment. The back face 204 is slightly convex in order to create a substantially parallel configuration with the front face 202. As explained above, the location, profile, and size of the ridges depend on the material characteristics and thickness of the faces 202, in addition to other factors. In some situations, computer simulations can be used to determine the preferred placements, size and profile of the ridges 206.

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**[0029]** At step 604, the front face 202 and the back face 204 are vacuum heat treated if the front face does not include securing tabs 502. In accordance with known techniques, the front face 202 and the back face 204 are each vacuum heat treated in order that the tensile strength ( $\sigma_{\text{BACK}}$ ) of the back face 204 is greater than or equal to the tensile strength ( $\sigma_{\text{FRONT}}$ ) of the front face 202 and the plasticity ( $\Phi_{\text{FRONT}}$ ) of the front face 202 is greater than or equal to the plasticity ( $\Phi_{\text{BACK}}$ ) of the back face 204.

**[0030]** At step 606, the back face 204 is positioned relative to the front face 202 and spot welded at a plurality of points. In the exemplary embodiment the back face 204 is centered within the area of the front face 202 and maintained in position while four spot welds are applied to the faces 202, 204. An example of a suitable welding technique includes a technique in accordance with Argon arc welding methods.

**[0031]** At step 608, it is determined whether the thicknesses of the faces 202, 204 require a pressurizing process. If the front face thickness is less than 1.6 mm and the back face thickness is less than 1.0, the procedure continues at step 610. Otherwise, the procedure continues at step 614.

**[0032]** At step 610, the back face 204 is welded to the front face 202 around the periphery of the back face 204 except for a small opening. An example of a suitable welding technique includes a technique in accordance with Argon arc welding methods.

**[0033]** At step 612, the sealed region 208 is pressurized. In the exemplary embodiment, carbon dioxide ( $\text{CO}_2$ ) is injected through the small opening to create a pressure of approximately 3-5 atmospheres within the sealed region.

**[0034]** At step 614, the weld is completed. In the exemplary embodiment, the back face 204 is welded to the front face 202 by applying a weldment 302 around the periphery of the back face 204. An example of a suitable welding technique includes a technique in accordance with Argon arc welding methods.

**[0035]** At step 616, the laminated golf club face 102 is vacuum heat treated. In accordance with known techniques, the laminated golf club face 102 is vacuum heat treated in order that the tensile strength ( $\sigma_{\text{BACK}}$ ) of the back face 204 is greater than or equal to the tensile strength ( $\sigma_{\text{FRONT}}$ ) of the front face 202 and the plasticity ( $\Phi_{\text{FRONT}}$ ) of the front face 202 is greater than or

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equal to the plasticity ( $\Phi_{\text{BACK}}$ ) of the back face 204. The heat treatment reduces or eliminates stress at the weldment 302 by forming a more consistent micro structure between the weldment 302 and the laminated face 102.

**[0036]** At step 618, the laminated golf club face 102 is finished. The edges of the faces 202, 204, weldments 302 are smoothed and polished. Any burrs or other deformities are removed in order to maximize the ease of securing the laminated golf club face 102 to the golf club head body 104.

**[0037]** Therefore, a laminated golf club face 102 is formed by welding a back face 204 to a front face 202. The weldment 302 is applied around the periphery of the back face 204 while the back face 204 is positioned within the center of the area of the front face 202. Heat treatments ensure the appropriate relationships between the face properties. The laminated golf club face 102 is welded to a golf club head body 104. The resulting golf club head 100 provides superior performance to conventional clubs by establishing a significantly larger area around the sweet spot where contact with a golf ball results in distances and accuracy comparable to the sweet spot. In addition, the characteristics and performance parameters of the resulting golf club do not exceed regulation limits such as the maximum COR allowed by the USGA.

**[0038]** Clearly, other embodiments and modifications of this invention will occur readily to those of ordinary skill in the art in view of these teachings. For example, an additional back face may be secured to the front face 202 or the back face 204 in some circumstances. The above description is illustrative and not restrictive. This invention is to be limited only by the following claims, which include all such embodiments and modifications when viewed in conjunction with the above specification and accompanying drawings. The scope of the invention should, therefore, be determined not with reference to the above description, but instead should be determined with reference to the appended claims along with their full scope of equivalents.

**[0039]** WHAT IS CLAIMED IS: